File "O" IN ITEK.

6 September 1961

Mr. Eugene Kiefer
Washington, D. C.

Dear Mr. Kiefer:

This letter contains a proposal for a research and development program for lightweight precision metal mirrors. The program outlined herein will be a joint effort of the Missiles & Space Systems Department of Hamilton Standard Division, United Aircraft Corporation and the ITEK Corporation. It consists of the design, fabrication and testing of four to five lightweight honeycomb plane mirrors at an approximate cost of $40,000 to $50,000 respectively. The entire program is expected to be completed in four months.

Lightweight Mirror Development Program

The Missiles & Space Systems Department of Hamilton Standard Division believes that significant advantages would accrue from replacing the conventional glass mirror blanks by blanks manufactured of metal honeycomb sandwich construction. A prime savings would be in weight, since metal honeycomb mirror blanks could be fabricated with a weight of one half to one quarter that of present cast aluminum blanks, while maintaining or improving upon the present stiffness. An experimental program will determine the effect of thermal environment on such designs. An additional improvement should arise in optical quality, since the face of a honeycomb mirror would be supported at much closer intervals. It seems probable that a cost savings might also arise due to possible savings in manufacture and polishing costs.

These advantages are predicted from a theoretical study of thefeasibility of mirror blank construction using metal honeycomb. It is obviously desirable that blanks should be fabricated with this new technique, and tests conducted to verify the theoretical prediction. To meet this need, Missiles & Space Systems, in conjunction with the ITEK Corporation, propose a research, development and test program divided into three phases, shown as follows:

Phase I - Study and selection of materials, particularly of the bonding materials used in the honeycomb construction. The aim is to select a combination of materials to give long term stability and adequate stiffness under a wide variety of environmental conditions, including thermal and vibrational stresses.

Phase II - Design and fabrication of a set of plane mirrors.

Phase III - Testing of the fabricated mirrors under a variety of environmental conditions.

Under Phase II, it is proposed to initially manufacture three mirrors of 10 inches diameter, of aluminum honeycomb with aluminum faces. We plan on utilizing epoxy, metal, or a combination bond for attaching the faces to the core. These small mirrors will be used for primary experimentation to determine optimum design criteria for the larger mirrors. All aluminum construction is selected to minimize the cost of the program at this point. The second phase of the program will involve the manufacture and test of one or two mirrors of 28 inches diameter. It is advantageous to make one mirror of this size of all aluminum construction to verify the extrapolation of the design data from the 10 inch size, and then it may be desirable to fabricate another mirror of this size with aluminum honeycomb and beryllium faces. The possibility of a beryllium honeycomb core is presently being studied and, if feasible, may be utilized in the final construction of the second 28 inch mirror. This would permit a further reduction in the mirror weight and may also be advantageous in further limiting changes in shape due to temperature.

If it is desired to keep the cost of the program to a minimum it might be possible to eliminate the large aluminum mirror, and proceed directly from the 10 inch aluminum mirrors to the 28 inch beryllium-faced mirror. Cost estimates for both courses of action are given here and are shown in the accompanying table.

The Missiles & Space Systems Department of UAC will perform the research, design and fabrication of the mirror blanks. The ITEK Corporation will perform polishing and finishing of the mirrors as well as the optical testing. The optical tests will determine the quality of the mirrors under standard conditions as well as when subjected to thermal stresses.

It is planned to complete the program four months from the date of contractual coverage with the first 10 inch mirror, flat to one half wavelength, completed in one month. The next two small mirrors, flat to a higher order of accuracy (probably 1/10 wavelength) will be ready at two week intervals thereafter. The large mirrors (28 inches in diameter) will be available three months after initiation of contract with tests completed by the end of the fourth month. For long term stability tests, it is desirable to continue accelerated aging tests on the large mirrors for a much longer period, but the four-month contract period would answer most of the questions on feasibility of the concept.

We believe that this program will materially aid in achieving the feasibility of our GRIST Program. If there are any changes or modifications

that you would care to incorporate in this program, please do not hesitate to discuss these with us. We are very much interested in the advantages offered by this proposed lightweight precision mirror development and are looking forward to working on this program for you.

Very truly yours,

Robert H. Shatz
Technical Director
Missiles & Space Systems Department

RHS/mla

The cost estimate for the complete program, on a cost-plus-fixed-fee basis is as follows:

Program Costs

Research and design labor; 591 hours at $5.05 per hour	$ 2,620.95
Labor overhead at 70%	1,834.66
Fabrication of mirror blanks (with aluminum honeycomb core)	13,355.00
ITEK costs for polishing and optical tests	26,000.00
Total cost	$43,790.61
G&A at 14.79%	6,476.63
Fee at 8%	4,021.38
Grand total	$54,288.62

If the 28 inch aluminum-faced mirror is excluded, the cost will be reduced to the following:

Research and design labor; 591 hours at $5.05 per hour	$ 2,620.95
Labor overhead at 70%	1,834.66
Fabrication of mirror blanks (with aluminum honeycomb core)	11,845.00
ITEK costs for polishing and optical tests	17,100.00
Total cost	$33,400.61
G&A at 14.79%	4,939.95
Fee at 8%	3,067.24
Grand total	$41,407.80

TRANSMITTAL SLIP	DATE
TO: Mr. Foster	
ROOM NO.	BUILDING

REMARKS:

I now find that the USAF has a contract for 1/2 million with American Optical in this area. Col. James is writing Gene K. a memo on the subject.

C/MA.

FROM: 484		
ROOM NO.	BUILDING	EXTENSION

FORM NO 241 1 FEB 55 REPLACES FORM 36-8 WHICH MAY BE USED. ☆GPO : 1957 - O - 439445

TRANSMITTAL SLIP	DATE 8 Sept 61
TO: Mr. Foster	
ROOM NO.	BUILDING

REMARKS:

Gene left this with me to evaluate: Ed Green has aluminum mirrors in his "O" item... already made & tested to 1/10 wave. He is sending us a write-up on his work. He also doesn't think that the honey-comb will hold during temperature variations.

C/MA

FROM: C/MAO		
ROOM NO.	BUILDING	EXTENSION

FORM NO 241 1 FEB 55 REPLACES FORM 36-8 WHICH MAY BE USED. ☆GPO : 1957 - O - 439445